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(54) **METHOD AND SYSTEM FOR FAIL-OPERATIONAL HANDOVER OF SERVICE DURING VEHICLE OPERATION**

(57) Provided a computer-implemented method for fail-operational handover for vehicle (310) operation, the method comprising the steps, it is an object of the present invention to improve the flexibility of the method. The object is solved by a) receiving a first signal (120) with a first service offer from a first service provider, the first signal including a first address, and a first identifier of a first service type; b) receiving a second signal (122) with a second service offer from a second service provider, the second signal including a second address, and a second identifier of a second service type; c) determining that the first identifier and the second identifier correspond to an identifier of a desired service type; d) storing the second address as a fail-operational address of the desired service type; e) sending a third signal (124) to the first address with a request to subscribe to the first service offer; f) operating the vehicle at least partially based on a service in accordance with the first service offer; and g) determining if the first service provider suffers an error and/or fault, and if so: i) send a fourth signal (130) to the second address with a request to subscribe to the second service offer, and ii) operating the vehicle at least partially based on a service in accordance with the second service offer.

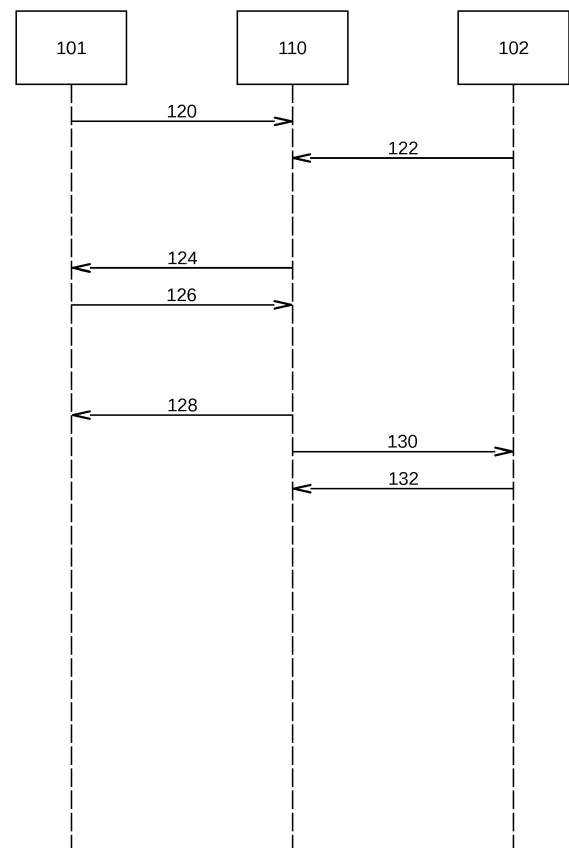


FIG 1

Description

[0001] The invention relates to a method for fail-operational service handover for vehicle operation, a system, a processing device, and a computer-readable medium for the same.

[0002] Autonomous Driving is one of the key E/E (electrical-electronic) architecture push factors in the automotive industry. The way towards autonomous driving is described in the SAE levels of the according norm SAE J3016 (trademark of SAE International). This norm describes six levels reaching from level zero to level five, where the latter contains the driver less driving or the fully automated driving.

[0003] In order for autonomous vehicles to operate safely where no human is required to take over in case of operation failure, the system driving the vehicle must be "fail-operational". The fail-operational requirement reflects the complex and varying environment the vehicle is operating in, and that merely shutting the vehicle off in case of failure (fail-safe in a narrow sense) is in many cases dangerous. Fail-operational can be defined as a system that is designed to be operational even in case of failure of a part of the system. Fail-operational can be used primarily in the context of safety-critical vehicle systems. The definition is however not limited to safety-critical systems, and may also be used in the context of less safety-critical systems, such as navigation systems or vehicle entertainment systems.

[0004] A fail-operational system may hand over from a primary (failing) part, to a secondary (fail-operational) part. A fail-operational part may be fully operational. In this case, the vehicle is fully operational in case of a failure in the primary part. In a fail-operational mode (operating on the fail-operational part), the system may also operational to a less extend and/or with less functionality. For safety-critical parts, this might involve at least functionality to a degree so that the system can safely bring the vehicle to halt at a safe location. An idea behind the "simplex architecture" is that the fail-operational part should be less complex and/or have fewer parts or instructions routines with fewer lines, and therefore be less likely to be failing. This allows a combination of the functionality of a complex system with the robustness of a simple system.

[0005] Fail-operational functions so far rely on structural redundancy. A parallel system take over the main system in case of failure of the main system. Structural redundancy requires pre-configured fail-operations behaviour and is therefore not flexible.

[0006] The invention includes realizing that structural redundancy may be replaced with dynamic redundancy. The invention further includes a solution for exchanging structural redundancy with dynamic redundancy in vehicle operation. The invention allows dynamic reconfiguration of redundant functions. The objective also includes minimizing the overall E/E-architecture and increasing the flexibility of fail-operational systems.

[0007] The object is solved by the method of claim 1, the system of claim 7, the device of claim 11, and computer-readable storage medium of claim 12.

[0008] In particular, the object is solved by a computer-implemented method for fail-operational service handover for vehicle operation, the method comprising the steps:

- a) receiving a first signal with a first service offer from a first service provider, the first signal including a first address, and a first identifier of a first service type;
- b) receiving a second signal with a second service offer from a second service provider, the second signal including a second address, and a second identifier of a second service type;
- c) determining that the first identifier and the second identifier correspond to an identifier of a desired service type;
- d) storing the second address as a fail-operational address of the desired service type;
- e) sending a third signal to the first address with a request to subscribe to the first service offer;
- f) operating the vehicle at least partially based on a service in accordance with the first service offer; and
- g) determining if the first service provider suffers an error and/or fault, and if so:

- i) send a fourth signal to the second address with a request to subscribe to the second service offer, and
- ii) operating the vehicle at least partially based on a service in accordance with the second service offer.

[0009] The fail-operational behaviour is based on a service-oriented architecture where service providers send (typically via broadcast or multicast) service offers over a data network. Service consumers may listen to broadcasted service offers and subscribe to services of interest. The service provider will usually only provide the offered service to the subscribing listeners (multicast). In case no consumer listens to a service, no data will necessarily be sent. In order to provide fail-operational behaviour using the service-oriented architecture, at least two service providers must be available offering the same service type; one primary, and one fail-operation (secondary).

[0010] By using a service-oriented approach, the structural redundancy may be replaced by dynamic redundancy allowing dynamic reconfiguration of safety crucial data communication. The functioning of a vehicle, such as SAE operation level, or the velocity limit of autonomous driving, may be adjusted to the number of redundant systems available.

[0011] The service provider may provide sensor information (such as velocity sensor), provide actuator ability (such as braking and steering), or computational capability (such as hardware accelerators or trajectory calcu-

lation). It may also provide less safety critical service, such as multimedia.

[0012] The priority of the service providers, i.e. which will be stored as fail-operation address, and which will be the preferred service provider, may be made predefined. It may also be decided depending on which service offer that is received first. It may also be made based on characteristics of the service provider, such as by determining information included in the service offer signals. It may also be decided based on the quality, granularity or speed of the service provided. A primary service provider may indicate itself as such in the service offer message, where any other service provider offering the same service type will be stored as secondary service provider (fail-operational).

[0013] Where the first service offer is determined to have lower priority than a later received service offer, the method may include stopping the subscription of the first received service provider, and storing the address of the first received service provider as fail-operational address, and sending a signal to the later received service offer address with a request to start subscribing to the later received service provider. Preferably, in order to reduce hand-over time. The second subscription is established before the subscription to the first service provider is cancelled to ensure continuous service.

[0014] The advantages further include that the second service provider may not necessary send data over the vehicle data network, where no subscription is made for the service, leading to lower overall network usage. Considering that substantial amount of dynamically redundant service providers may be present in a vehicle, in particular in autonomous vehicles, reducing redundant data traffic may be crucial for operation.

[0015] Service provider instructions/data may be received/sent using the same network as the network over which the service offer signal is received. The network may be an Ethernet based network. The data may also be sent over a separate logical or physical network, such as over a CAN or a FlexRay network. In one example, the vehicle includes redundant braking systems that offer a first and a second braking service respectively as service providers. The first and the second braking service provider may send signals over a first physical or logical network, such as an Ethernet and/or IP based network, identifying them as offering braking service. A vehicle control unit may receive the signals. The braking control unit may subscribe to the first and/or second service provider as described herein by sending a request over the same network. The actual braking instructions from the vehicle control unit may be sent over the same, or a separate physical or logical network, such as over a CAN or a FlexRay network. Real-time constraints may be facilitated by sending the braking instructions via a separate network.

[0016] In one embodiment, the determining in step g) is done by determining data and/or a keep-alive message is not received within a pre-described time interval and/or

by sending a message to the first address requesting a status update and/or by receiving a message from the first address with a status update and/or by monitoring the data received from the first service provider.

[0017] The advantages of determining errors of faults using a time-interval include that determination may be possible also of failure external to the service provider, such as power and/or communication failure. The advantages of determining errors of faults by sending a message to the first address requesting a status update include that the time or frequency of determining can be decided on the service consumer side. The advantages of determining errors of faults by receiving a message from the first address with a status update include that a more detailed status level can be assessed, such as a particular quality of service. The advantages of determining errors of faults by monitoring the data received include that data may be compared with independent data providers to assess if the data is reliable.

[0018] In one embodiment, the first and/or the second signal are received complying to a SOME/IP (Scalable service-Oriented MiddlewarE over IP) protocol, preferably using Service Discovery (SOME/IP-SD) OfferService Entry, and/or the third and/or the fourth signal are sent according to the SOME/IP protocol, preferably using Service Discovery Subscribe Eventgroup Entry.

[0019] By using SOME/IP, in particular SOME/IP Service Discovery, in particular according to AUTOSAR SOME/IP Protocol Specification 1.0.0 or later, preferably AUTOSAR SOME/IP Protocol Specification 1.5.0 or later, a sender only sends data when at least one receiver in the network needs this data. The advantages include that the network is not loaded by unnecessary data. Further, several service consumer may subscribe to the same service provider and data may be multicasted only to those processes needing the data.

[0020] Data may be received from the first service provider using SOME/IP events or by other means over IP, over Ethernet, or over a separate network such as a CAN or FlexRay network.

[0021] In one embodiment, if the first service provider suffers an error and/or fault, the method further comprises:

iii) sending a signal to the first service address with a request to stop the subscription of the first service offer.

[0022] The advantages include that the first service provider will be informed that the service consumer does not use the first service provider any more. The first service provider may then stop sending data to the service consumer. If no other service consumers are listen to the first service provider, the first service provider may stop sending data on the network and even stop generation, leading to less unnecessary data on the network, less processing power utilized and less power consumption. On notification of a detected fault in the received data, the first service provider may initiate a recovery procedure, such as a restart or sensor/system clean, in an effort to increase the reliability of service. If the recovery

procedure is successful, the first service provider may initiate a service offer broadcast on the network, informing potential service consumer that the service provider is available for subscription again.

[0023] In one embodiment, the method further comprising:

monitoring the second service provider, and in response to a change in the second service offer, updating or removing the second address as fail-operational address.

[0024] The advantages include a more flexible way to increase safety during vehicle operation. For safety-critical functions, at least two independent service providers (one redundant) should preferably be present at all time of operation. Where more than two service providers are present of a service type, the further may stop subscription without interfering with the fail-operational requirement of the system. In one example, a human, such as a back-up driver may be alerted in case the redundancy of the system fails, and the autonomous operation may continue with a human as a fail-operational "system". In one example, the full autonomous driving may be limited to certain areas or certain conditions, such as areas with particular road guidance systems, or conditions in good weather and/or visibility. In this case a service provider may indicate that it no longer providing a service outside the areas and/or conditions. A human ("fail-operational") driver may also be remote from the vehicle, such as controlling the vehicle via data link.

[0025] In one embodiment, the method further comprising:

receiving at least one further signal with a further service offer, the further signal including a further address, and a further identifier of a service type; determining that the further identifier corresponds to the identifier of the desired service type; and storing the further address as a further fail-operation address of the service type.

[0026] The advantages includes further safety of operation with one or more further service providers that may be used for fail-operation in case of failure in the first and the second service provider. In one example, the further service providers will only be subscribed to if the first and second service providers fails in order not to consume network bandwidth usage during normal operation.

[0027] The above-stated methods may further comprise features of the below-stated systems.

[0028] In particular, the object of the present invention is further solved by a system for fail-operational service handover for vehicle operation, in particular a system comprising means for carrying out the steps of the above-stated methods, the system comprising:

a vehicle, the vehicle comprising a computer-implemented service consumer for operating the vehicle; a first service provider;

a second service provider;

a failure detection device; and

a data communication network, the data communication network connecting the first service provider and the second service provider with the service consumer,

wherein the system comprises means for carrying out the steps:

a) receiving, at the service consumer, a first signal with a first service offer from the first service provider, the first signal including a first address, and a first identifier of a first service type;

b) receiving, at the service consumer, a second signal with a second service offer from the second service provider, the second signal including a second address, and a second identifier of a second service type;

c) determining that the first identifier and the second identifier correspond to an identifier of a desired service type;

d) storing the second address as a fail-operational address of the desired service type;

e) sending a third signal to the first service provider with a request to subscribe to the first service offer;

f) operating the vehicle at least partially based on a service in accordance with the first service offer; and

g) determining, by the failure detection device, if the first service provider suffers an error and/or fault, and if so:

i) send a fourth signal to the second service provider with a request to subscribe to the second service offer, and

ii) operating the vehicle at least partially based on a service in accordance with the second service offer.

[0029] The benefits and advantages of the system are equal or similar to the advantages of the above-mentioned method.

[0030] In one embodiment, the first service provider and/or the second service provider are located remote of the vehicle.

[0031] The advantages include that service provider does not necessary be built into the vehicle during manufacturing and/or during vehicle garage service. The vehicle can therefore be built with fewer parts. Remotely accessed service providers may also be easier to upgrade than hardware/software build into the vehicle. The use of an IP based protocol, such as the SOME/IP protocol further facilitate remote access to remote service provider available over an IP network, such as the Internet.

[0032] In one embodiment, the vehicle comprises the first service provider and/or the second service.

[0033] Installing service providers as part of the vehicle allows communication over the vehicle network, facilitating compliance to real-time requirements. The service-oriented approach still allows components providing services to be uninstalled and/or replaced by other components providing the same service, at a late stage of manufacturing, or during garage service. Under certain condition, the components may even be "hot-swapped" during operation/transport.

[0034] A mix of remote and local service providers may also be used. The advantages include that a fail-operational service provider may be accessed over a network, external to the vehicle, such as via a wireless connection to the Internet. The remotely accessed service provider may have longer delay, and therefore be suitable for reduced vehicle functionality, but although operational and functional, such as at lower velocities. This may be the fail-operational service provider, while the full functional service provider is located in the vehicle with direct access to the vehicle internal communication network.

[0035] The remotely accessed service provider may also be providing increased functionality, such as by having accessed to more external data and/or more processing power, which may be needed for high speed operation. In this case, the service provider on the vehicle local data network may be the fail-operational service provider with reduced functionality.

[0036] In one embodiment, the system further comprises:

a further service provider
wherein the vehicle comprises the further service provider or the further service provider is remote of the vehicle.

[0037] The advantages include that additional redundancy may be provided. For some services, such as very safety critical services, the level of operation may depend on the number of redundant services, rather than on the quality of the services, such as that full vehicle velocity will only be available for example with a minimum of three independent service providers available. Two independent service providers will reduce functionality, such as velocity, and only one will initiate a function to safely bring the vehicle to halt in a safe location or require human to take over control.

[0038] The benefits and advantages of the computer readable medium and processing device are equal or similar to the advantages of the above-mentioned method and system.

[0039] In the following, embodiments of the invention are described with respect to the figures, wherein

Fig. 1 shows a flowchart of sending and receiving signals according to an embodiment of the invention.

Fig. 2 shows steps of a method of fail-operational service handover for vehicle operation accord-

ing to an embodiment of the invention.

Fig. 3 shows a system for fail-operational handover for vehicle operation according to an embodiment of the invention.

[0040] Fig. 1 shows a flowchart, including first service provider 101, a second service provider 102, and a service consumer 110. The first service provider 101 sends a first signal 120 with first service offer. The signal may be broadcasted on a network and received by the service consumer 110. The second service provider 102 sends a second signal 122 with second service offer. The signal may be broadcasted on a network and received by the service consumer 110. The service consumer 110 may determine that the first service provider and the second service provider both corresponds to a desired service type, such as by comparing identifiers carried by the first and the second signals. The service consumer 110 may also compare the identifiers with a pre-stored identifier of a desired service type. The service consumer may decide that the first service provider 101 is the preferred service provider. It may then store the address of the second service provider 102 as a fail-operational address. It may also send a third signal 124 to the first service provider 101 with subscription request. Data may now be received 126 from the first service provider 101 and the vehicle may be operated based on the data received.

[0041] If the service consumer determines that the first service provider suffers a fault and/or error, it may send a fourth signal 130 with subscription request to the second service provider and operating the vehicle at least partially based on a service in accordance with the second service offer. Optionally the service consumer may also send a signal 128 to the first service provider 101 to stop the subscription of the service.

[0042] Although the first service provider 101 is depicted as being the primary service provider, the first service provider 101 may also be the secondary service provider (fail-operational).

[0043] Fig. 2 shows steps of a method for fail-operational service handover for vehicle operation. The method may include receiving 210 a first signal with a first service offer, receiving 220 a second signal with a second service offer, determining 230 that the first and second identifier correspond to a desired service type, storing 240 the second address as fail-operational, sending 250 signal to the first address with a request to subscribe, operating 260 the vehicle at least partially based on a service in accordance with the first service offer, and determining 270 if the first service provider suffers an error and/or fault. A decision 275 is made based on determining. If the first service offer suffer from a fault or error or is unreliable for other reasons, the method will send 280 a signal to the (fail-operational) second address with a request to subscribe, and further 290 operate the vehicle based on data received from second service provider. If not, the vehicle will continue to be operated based on data received from the first service provider.

[0044] Fig. 3 shows a system 300 for fail-operational service handover for vehicle operation. The system includes a vehicle 310, a service consumer 320, a first service provider 330, a second service provider 340, and a communication channel 360. The service consumer 320 operates the vehicle based on data received from the first service provider 330 or the second service provider 340. Fig. 3 shows the first service provider 330 located in the vehicle 310, and the second service provider 340 located remote of the vehicle 310. This is only an example and both service providers may be located in the vehicle or remote or any mix thereof. The system may also be extended to further service providers. The communication channel 360 may be initiated over a network connecting the service consumer 320 with the second service provider 340. The first service provider 330 may be connected to the service consumer 320 via a vehicle data network.

[0045] In one example, the first service provider 330 may be an ECU (electronic control unit) calculating vehicle trajectory for safely driving the vehicle 310 on a street. The service consumer 320 may be another ECU steering the vehicle, such as via controlling servos adjusting the direction of the front wheels. The service consumer 320 may be programmed to adjust the front wheel direction based on a signal indicating a target wheel direction.

[0046] The first service provider may broadcast a signal with service offer on the vehicle data network, the signal including an identifier of a service type of providing steering directions. The service consumer 320 may listen on the network, identifying the service offer and subscribe to the first service provider. The vehicle will be steered based on data received by the service consumer 320 from the first service provider 330.

[0047] The second service provider 340 may be a cloud based vehicle guidance algorithm, that based on data received from the vehicle 310, road cameras (not shown), other vehicles (not shown) etc., may provide steering instructions to the vehicle 310. The second service provider 340 may multicast service offer on the Internet, received by the vehicle 310. When the second service 340 provider is available and sends a service offer to the vehicle 310, the vehicle 310 may store an address of the second service offer as a fail-operational address. In case the first service provider 330 fails, the service consumer 320 may subscribe to the second service provider 340. The vehicle 310 may not be steered based on steering directions receive from the second service provider 340.

[0048] In another example, the service consumer 320 is a vehicle sound system. The first service provider 330 may be a radio unit receiving radio channels via AM/FM bands. The second service provider 340 may be an Internet server providing radio channels over Internet. In order to reduce network usage, the first service provider 330 may be chosen to be the primary service provider. In case the reception of the radio is reduced, such as by

entering a tunnel, the service consumer 320 may determine that the received radio signals are below a certain quality threshold. The service consumer 320 may then send a signal to the second service provider 340 with a request to start a subscription. The service consumer may also send a signal to the first service provider 330 indicating that it stop the subscription. The first service provider 330 may not stop sending sound data over the vehicle local data network. The first service provider 330 may also close down certain parts in order to reduce power consumption.

Reference numerals

[0049]

101	first service provider
102	second service provider
110	service consumer
120	first signal with first service offer
122	second signal with second service offer
124	third signal with subscription request
126	vehicle operation data from first service provider
128	(Optional) signal to stop subscription
130	fourth signal with subscription request
132	vehicle operation data from second service provider
210	receiving a first signal with a first service offer
220	receiving a second signal with a second service offer
230	determining that the first and second identifier correspond to a desired service type
240	storing the second address as a fail-operational
250	sending signal to the first address with a request to subscribe
260	operating the vehicle based on a first service
270	determining if the first service provider suffers an error and/or fault
275	decision based on determining
280	sending signal to the second address with a request to subscribe
290	operating the vehicle based on a second service
300	system for fail-operational service handover
310	vehicle
320	service consumer
330	first service provider
340	second service provider
350	Failure detection unit
360	communication channel

Claims

1. A computer-implemented method for fail-operational service handover for vehicle (310) operation, the method comprising the steps:

a) receiving a first signal (120) with a first service

- offer from a first service provider, the first signal including a first address, and a first identifier of a first service type;
- b) receiving a second signal (122) with a second service offer from a second service provider, the second signal including a second address, and a second identifier of a second service type;
- c) determining that the first identifier and the second identifier correspond to an identifier of a desired service type;
- d) storing the second address as a fail-operational address of the desired service type;
- e) sending a third signal (124) to the first address with a request to subscribe to the first service offer;
- f) operating the vehicle at least partially based on a service in accordance with the first service offer; and
- g) determining if the first service provider suffers an error and/or fault, and if so:
- i) send a fourth signal (130) to the second address with a request to subscribe to the second service offer, and
 - ii) operating the vehicle at least partially based on a service in accordance with the second service offer.
2. The method of claim 1, wherein the determining in step g) is done by determining that data and/or a keep-alive message is not received within a pre-described time interval and/or by sending a message to the first address requesting a status update and/or by receiving a message from the first address with a status update and/or by monitoring the data received from the first service provider.
3. The method of claims 1 or 2, wherein the first and/or the second signal are received complying to a SOME/IP protocol, preferably using Service Discovery OfferService Entry, and/or the third and/or the fourth signal are sent according to the SOME/IP protocol, preferably using Service Discovery Subscribe Eventgroup Entry.
4. The method of any of the claims 1 to 3, wherein, if the first service provider suffers an error and/or fault, the method further comprises:
- iii) sending a signal (128) to the first service address with a request to stop the subscription of the first service offer.
5. The method of any of the claims 1 to 4, the method further comprising:
- monitoring the second service provider, and in response to a change in the second service offer, updating or removing the second address as fail-operational address.
6. The method of any of the claims 1 to 5, the method further comprising:
- receiving at least one further signal (120) with a further service offer, the further signal including a further address, and a further identifier of a service type;
- determining that the further identifier corresponds to the identifier of the desired service type; and
- storing the further address as a further fail-operation address of the service type.
7. A system (300) for fail-operational service handover for vehicle operation, in particular a system comprises means for carrying out the steps of the method of one of the claims 1 to 6, the system comprising:
- a vehicle (310), the vehicle (310) comprising a computer-implemented service consumer (320) for operating the vehicle (310);
- a first service provider (330);
- a second service provider (340);
- a failure detection device (350); and
- a data communication network (360), the data communication network (360) connecting the first service provider (330) and the second service provider (340) with the service consumer (320),
- wherein the system (320) comprises means for carrying out the steps:
- a) receiving, at the service consumer (320), a first signal (120) with a first service offer from the first service provider (330), the first signal including a first address, and a first identifier of a first service type;
 - b) receiving, at the service consumer (320), a second signal (122) with a second service offer from the second service provider (340), the second signal including a second address, and a second identifier of a second service type;
 - c) determining that the first identifier and the second identifier correspond to an identifier of a desired service type;
 - d) storing the second address as a fail-operational address of the desired service type;
 - e) sending a third signal (124) to the first service provider (330) with a request to subscribe to the first service offer;
 - f) operating the vehicle at least partially based on a service in accordance with the first service offer; and
 - g) determining, by the failure detection de-

vice (350), if the first service provider (330) suffers an error and/or fault, and if so:

- i) send a fourth signal (130) to the second service provider (340) with a request to subscribe to the second service offer, and 5
- ii) operating the vehicle at least partially based on a service in accordance with the second service offer. 10

8. The system of claim 7, wherein the first service provider and/or the second service provider are located remote of the vehicle. 15
9. The system of claims 7 or 8, wherein the vehicle comprises the first service provider and/or the second service. 20
10. The system of any of the claims 7 to 9, the system further comprising: 25
- a further service provider wherein the vehicle comprises the further service provider or the further service provider is remote of the vehicle. 30
11. A processing device comprising means for carrying out the method of any of the claims 1 to 6. 35
12. A computer-readable medium comprising instructions which, when executed by a processor, cause the processor to carry out the steps of the method of any of the claims 1 to 6. 40

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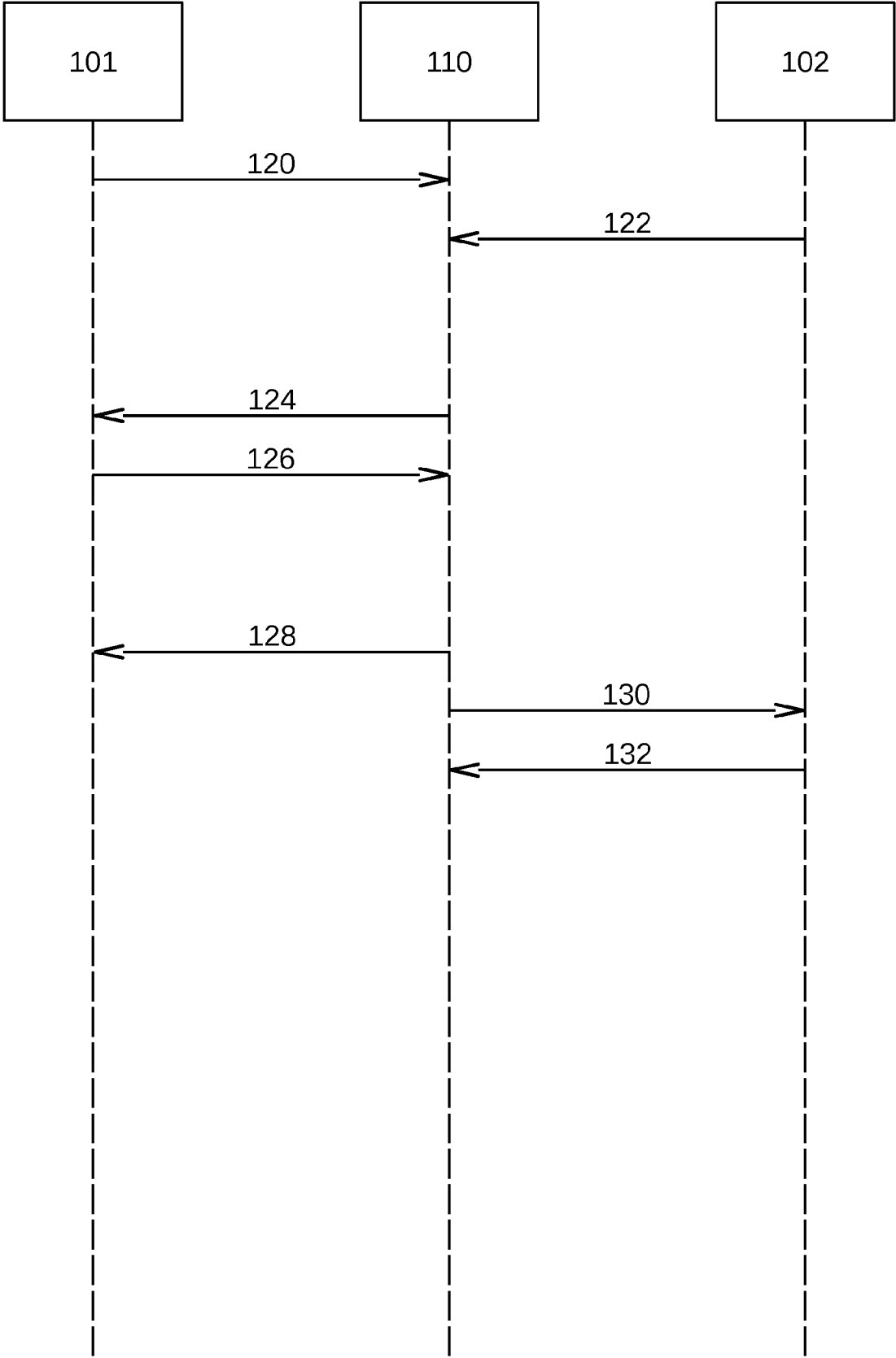


FIG 1

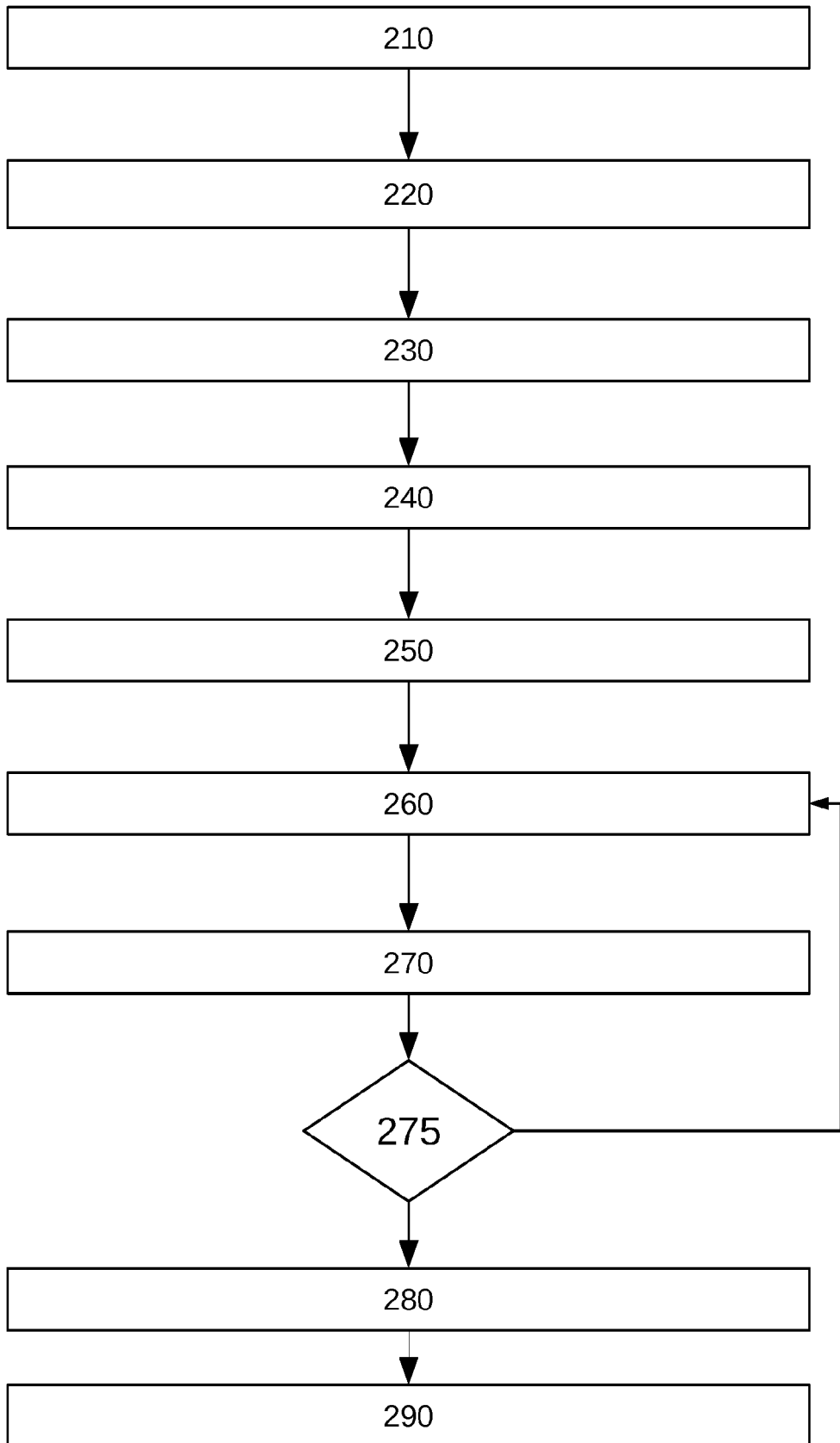


FIG 2

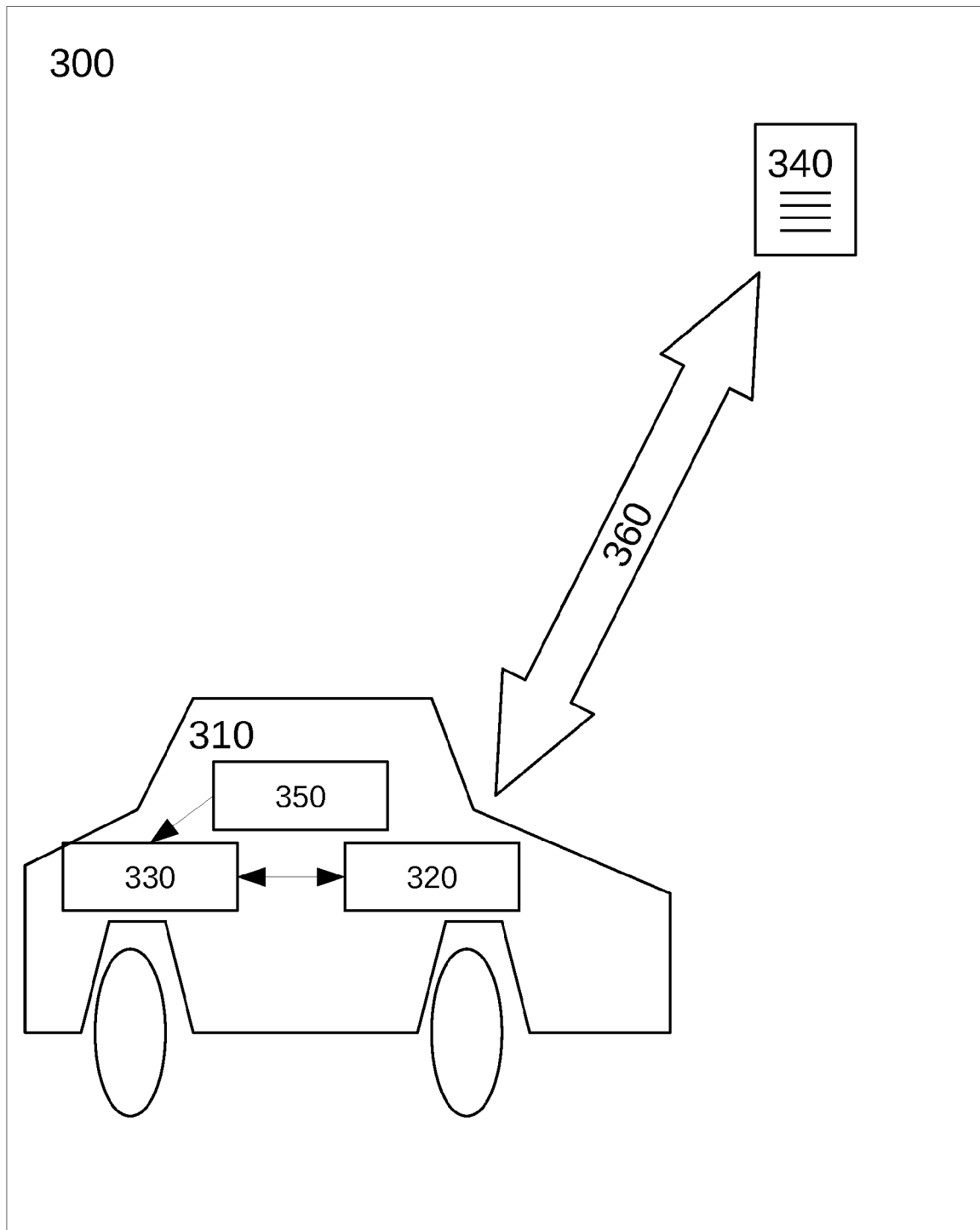


FIG 3



EUROPEAN SEARCH REPORT

 Application Number
 EP 19 17 0018

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/129060 A1 (COOPER JARED KLINEMAN [US] ET AL) 8 May 2014 (2014-05-08) * paragraph [0100] - paragraph [0109]; figure 10 *	1-12	INV. G05D1/02 G05D1/00
A	US 9 195 232 B1 (EGNOR DANIEL TRAWICK [US] ET AL) 24 November 2015 (2015-11-24) * column 11, line 46 - column 15, line 5; figure 3 *	1-12	ADD. B60W30/00 B60R16/00 G06F11/00
A	US 2017/139411 A1 (HARTUNG JOSHUA JOHN [US] ET AL) 18 May 2017 (2017-05-18) * paragraph [0110] - paragraph [0125] *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			G05D B60W G06F B60R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 August 2019	Examiner Thomann, Jérôme
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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